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(54) **CUTTER, CUTTING MEMBER AND CUTTING APPARATUS**

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B26D 7/26 (2006.01)
B26F 1/38 (2006.01)
B26D 5/06 (2006.01)

(52) **U.S. Cl.**

CPC ***B26D 7/2628*** (2013.01); ***B26D 5/06*** (2013.01); ***B26D 7/2614*** (2013.01); ***B26F 1/3813*** (2013.01); *Y10T 83/8765* (2015.04)

(58) **Field of Classification Search**

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USPC 83/575, 940, 614, 370, 563, 284, 83/698.11, 582, 635, 646, 554, 633, 881, 83/856, 879, 700, 941, 880, 71, 72, 74; 408/13
See application file for complete search history.

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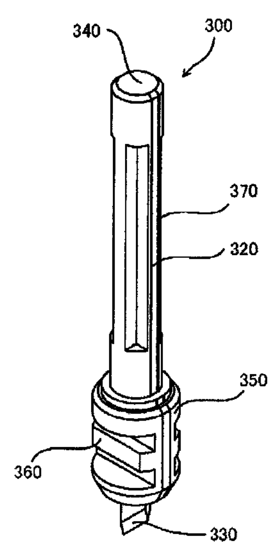
(57) **ABSTRACT**

A cutter, detachably attachable to a support member, includes a shaft made of a resin and has a smaller-diameter portion and a larger-diameter portion formed integrally with the shaft. The smaller-diameter portion is rotatably supported by a plurality of bearings. The larger-diameter portion has a proximal end surface abutting on an end surface of one of the bearings, with a result that the cutter is locked. The cutter includes a flat blade located on a distal end of the larger-diameter portion. The cutter includes a metal member which can be attracted by a magnet located on the support member. The metal member is located on a distal end of the smaller-diameter portion. Contact portions are located on axially differing portions of the shaft respectively and are capable of contacting the bearings respectively. Thinned parts are located between the contact portions and extend in the axial direction of the shaft.

15 Claims, 9 Drawing Sheets



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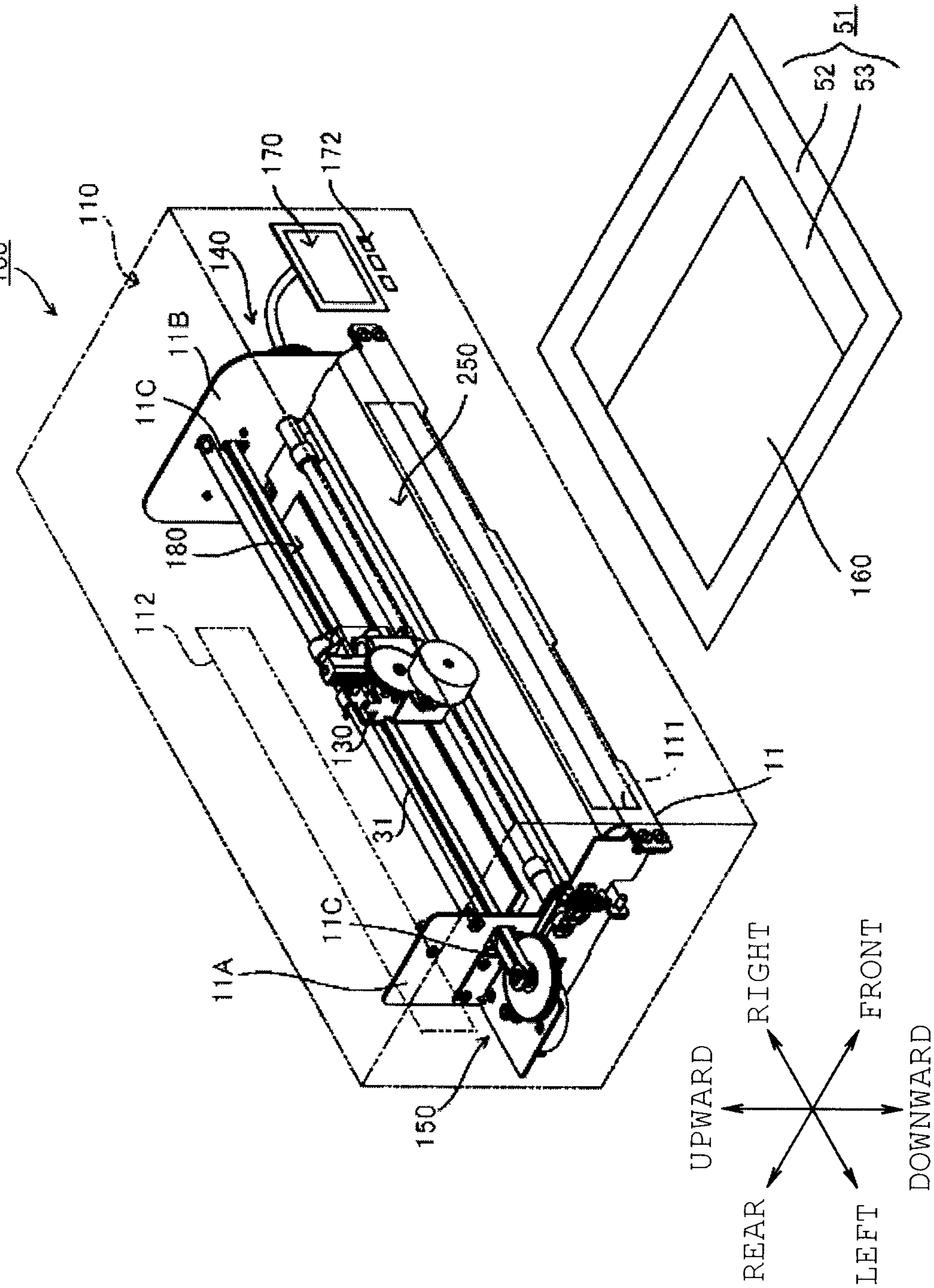
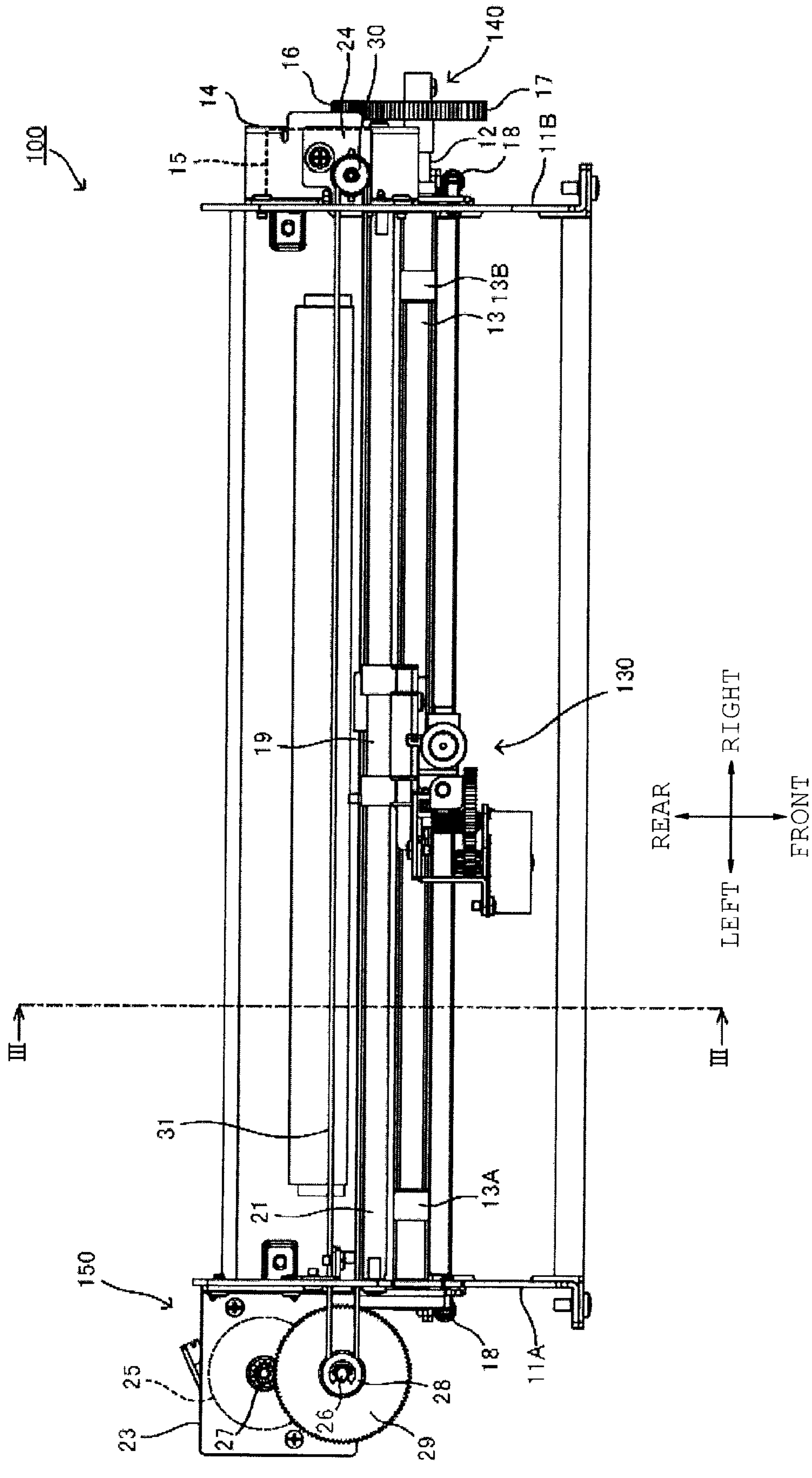

100
110
140
170
172
11B
11C
250
180
112
130
111
11
31
11C
11A
150
52
53
51
160
UPWARD
RIGHT
FRONT
DOWNWARD
LEFT
REAR

FIG.1


100
140
16
24
30
14
17
15
12
18
11B
13B
13
130
19
RIGHT
REAR
FRONT
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III
III
31
21
13A
150
18
11A
25
28
23
27
26
29

FIG.2

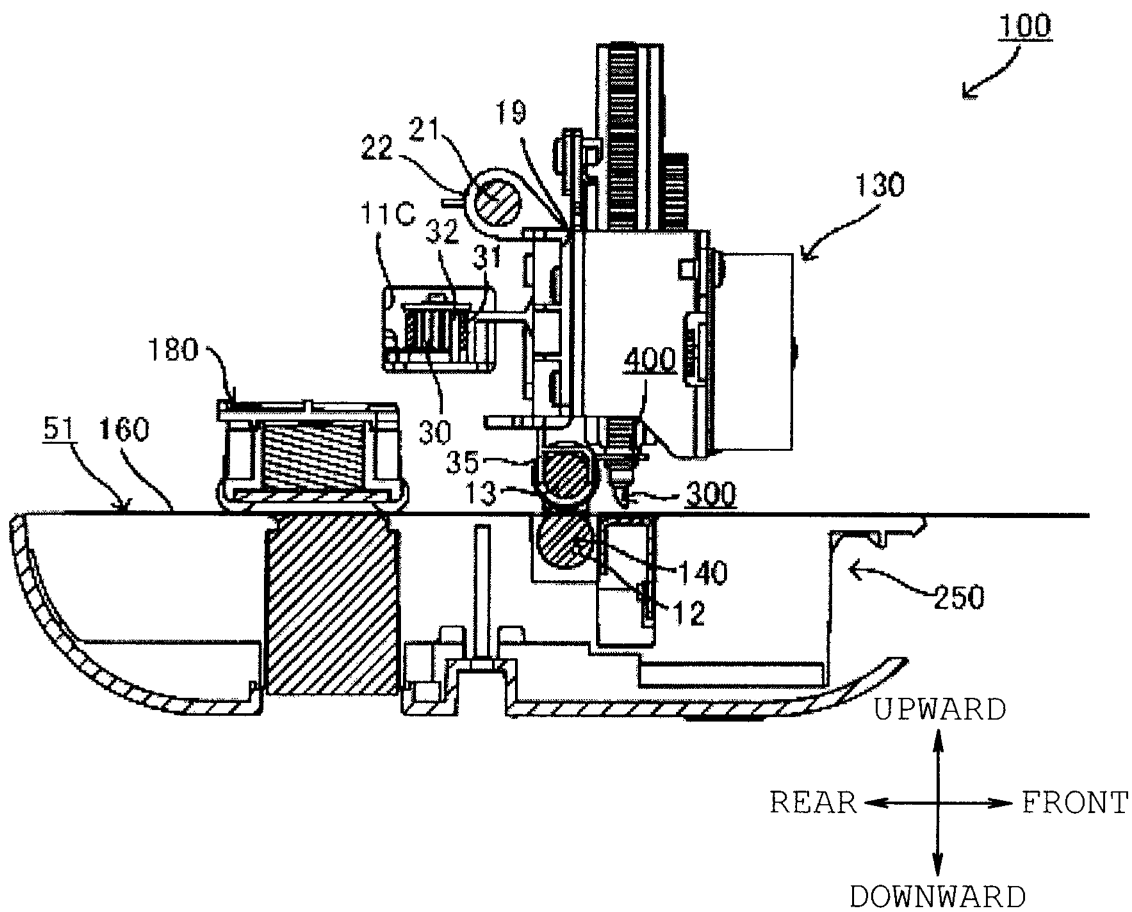
100
130
19
21
22
11C
32
31
180
400
30
51
160
35
13
300
140
250
12
UPWARD
REAR
FRONT
DOWNWARD

FIG. 3

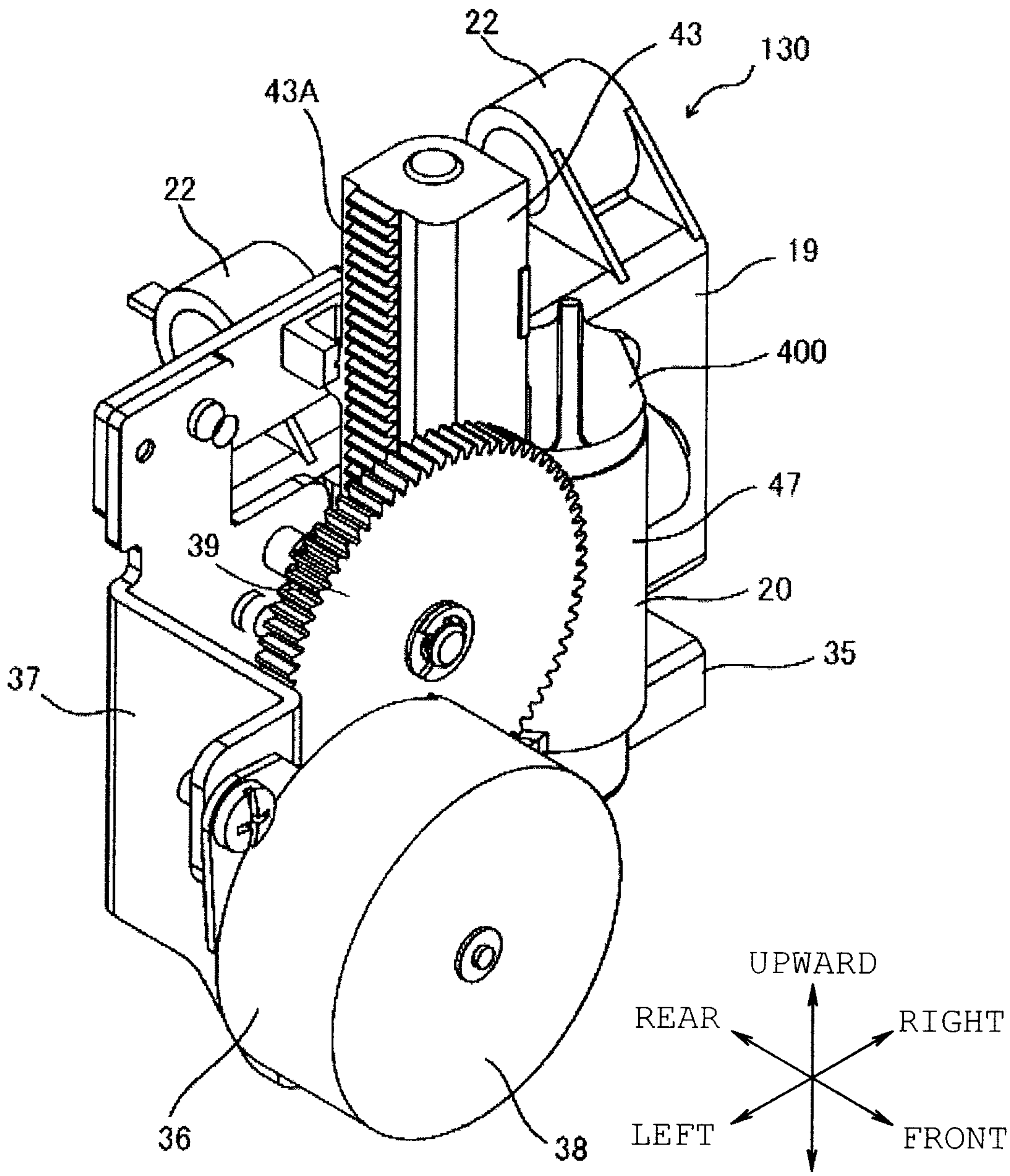
22
43
130
43A
22
19
400
47
39
20
35
37
UPWARD
REAR
RIGHT
LEFT
FRONT
DOWNWARD
36
38

FIG. 4

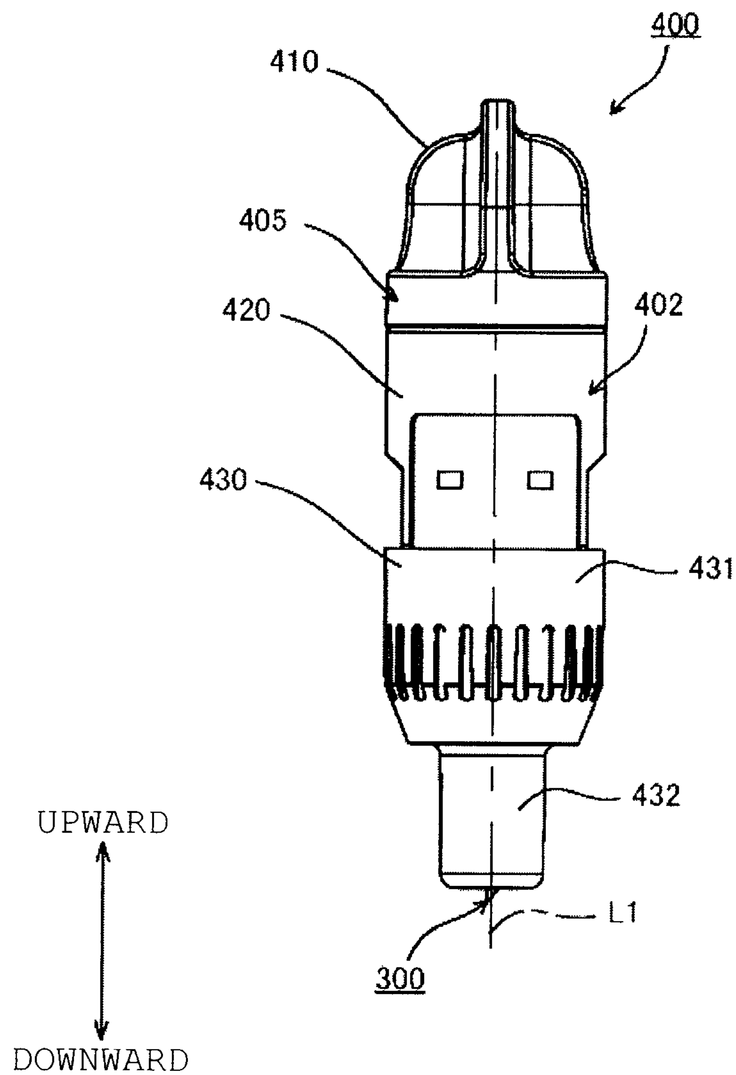

FIG. 5

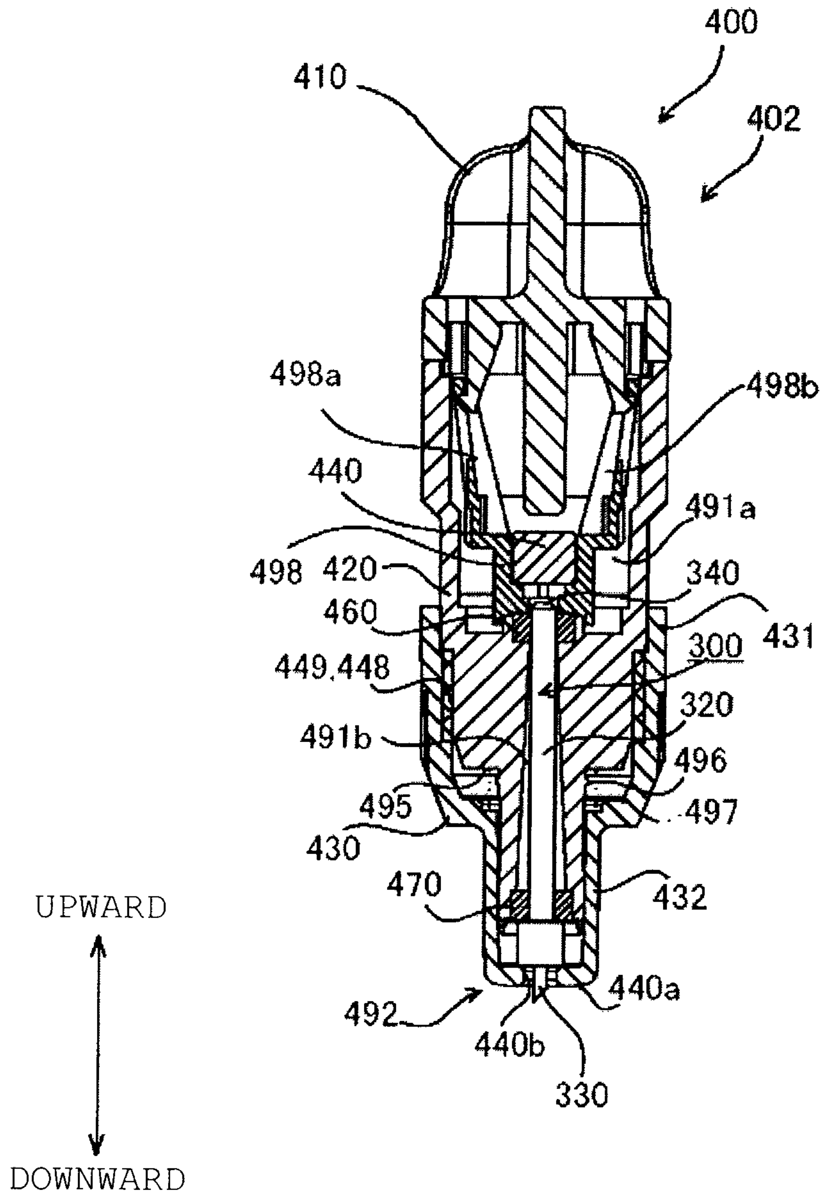
400
410
402
498a
498b
440
491a
498
420
340
431
460
300
449,448
320
491b
496
495
497
430
470
432
UPWARD
DOWNWARD
492
440a
440b
330

FIG. 6

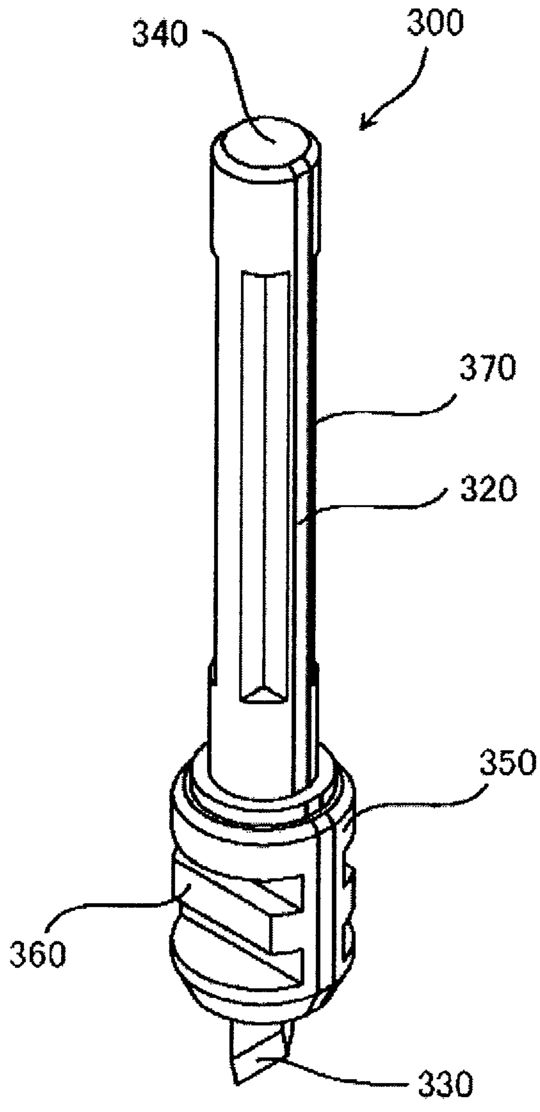

FIG. 7

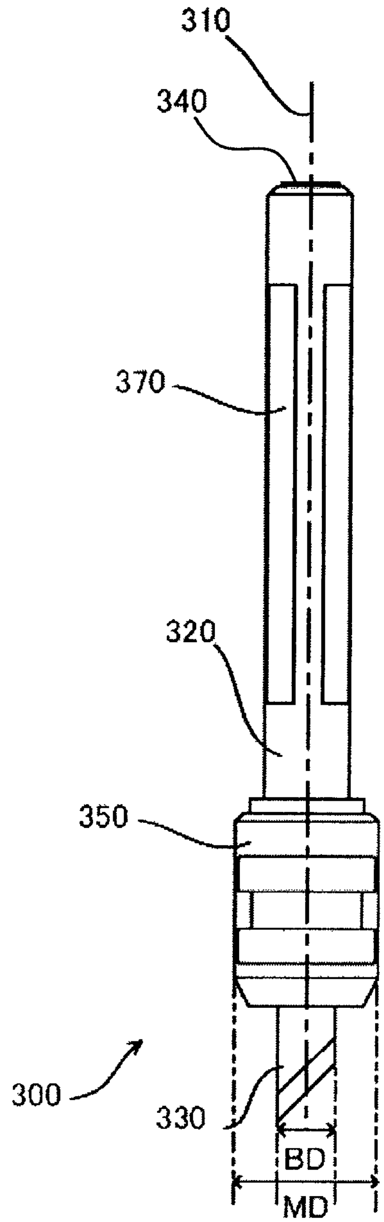

FIG. 8

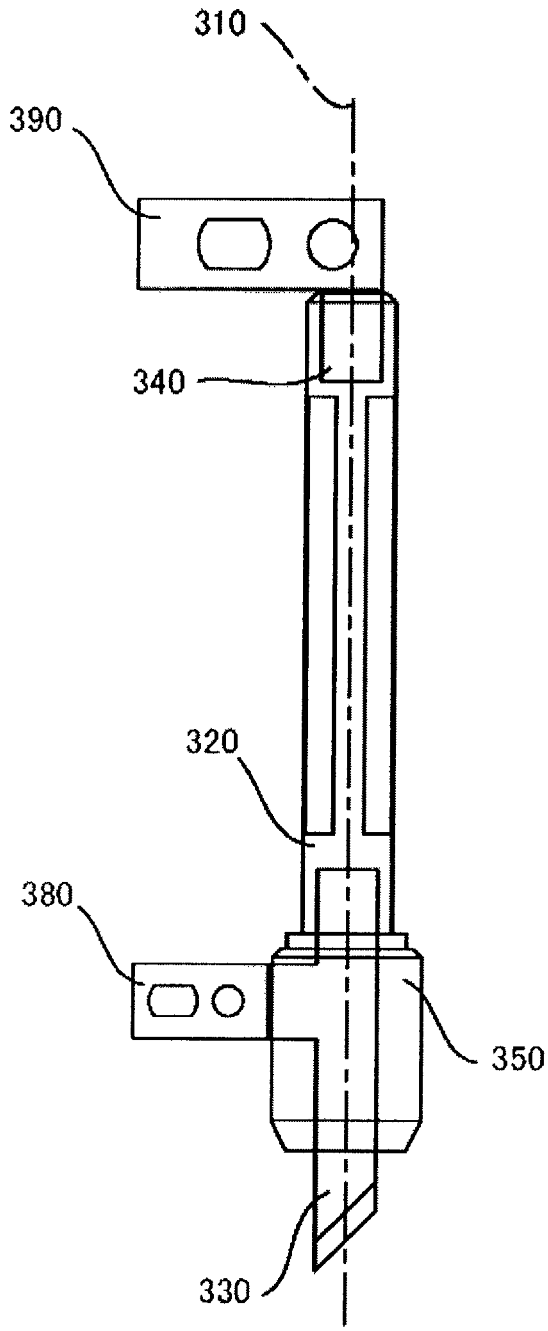

FIG. 9

CUTTER, CUTTING MEMBER AND CUTTING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2013-071538 filed on Mar. 29, 2013, the entire contents of which are incorporated herein by reference.

BACKGROUND

1. Technical Field

The present disclosure relates to a cutter capable of cutting a sheet-shaped object, a cutting member including the cutter and a cutting apparatus to which the cutting member is detachably attachable.

2. Related Art

A cutting apparatus, such as a cutting plotter, has been conventionally known which automatically cuts a sheet-shaped object. The cutting plotter includes a cutting pen which is used to cut the object. The cutting pen includes a cutting pen holder on which is rotatably held a cutter part having a cutting blade. The cutter part is formed of a bar material made of a metal such as carbon steel. The cutter part is an article of consumption. Accordingly, the cutter part is attracted to cutting pen holder by magnetic force thereby to be attached thereto and is accordingly replaceable easily. However, the cutter part has conventionally been manufactured by cutting a metal bar material. This increases manufacturing costs.

SUMMARY

Therefore, an object of the disclosure is to provide a cutter which can be manufactured at lower costs, a cutting member including the cutter and a cutting apparatus to which the cutting member is detachably attachable.

The present disclosure provides a cutter which is detachably attachable to a support member, the cutter including a shaft made of a resin and having a smaller-diameter portion and a larger-diameter portion with a larger diameter than the smaller-diameter portion, the smaller-diameter portion and the larger-diameter portion being formed integrally with the shaft, the smaller-diameter portion being rotatably supported by a plurality of bearings bearing provided on the support member, the larger-diameter portion having a proximal end surface abutting on an end surface of one of the bearings, with a result that the cutter is locked in a state where an axial position of the cutter relative to the support member is immovable. The cutter further includes a flat blade provided on a first end which is a distal end of the larger-diameter portion, the flat blade cutting an object to be cut, a metal member which can be attracted by a magnet provided on the support member, the metal member being provided on a second end which is a distal end of the smaller-diameter portion, a plurality of contact portions provided on axially differing portions of the shaft respectively, the contact portions being capable of contacting the bearings respectively, and a plurality of thinned parts provided between the contact portions and extending in the axial direction of the shaft.

The disclosure also provides a cutting member includes a support member to which a cutter is detachably attached, thereby supporting the cutter, the support member having a plurality of bearings rotatably supporting the cutter and a magnet configured to position the cutter. The cutter includes a shaft made of a resin and having a smaller-diameter portion and a larger-diameter portion with a larger diameter than the smaller-diameter portion, the smaller-diameter portion and the larger-diameter portion being formed integrally with the shaft, the smaller-diameter portion being rotatably supported by the bearings provided on the support member, the larger-diameter portion having a proximal end surface abutting on an end surface of one of the bearings, with a result that the cutter is locked in a state where an axial position of the cutter relative to the support member is immovable. The cutter further includes a flat blade provided on a first end which is a distal end of the larger-diameter portion, the flat blade cutting an object to be cut, a metal member which can be attracted by the magnet provided on the support member, the metal member being provided on a second end which is a distal end of the smaller-diameter portion, a plurality of contact portions provided on axially differing portions of the shaft respectively, the contact portions being capable of contacting the bearings respectively, and a plurality of thinned parts provided between the contact portions and extending in the axial direction of the shaft.

The disclosure further provides a cutting apparatus comprising an object transfer mechanism configured to transfer a holding member holding an object to be cut, a cutter moving mechanism configured to move a cutting head provided with a holder in a direction intersecting a direction in which the holding member is transferred, and a cutting member attached to the holder. The cutting member includes a support member to which a cutter is detachably attached, thereby supporting the cutter, the support member having a plurality of bearings rotatably supporting the cutter and a magnet configured to position the cutter. The cutter includes a shaft made of a resin and having a smaller-diameter portion and a larger-diameter portion with a larger diameter than the smaller-diameter portion, the smaller-diameter portion and the larger-diameter portion being formed integrally with the shaft, the smaller-diameter portion being rotatably supported by the bearings provided on the support member, the larger-diameter portion having a proximal end surface abutting on an end surface of one of the bearings, with a result that the cutter is locked in a state where an axial position of the cutter relative to the support member is immovable. The cutter further includes a flat blade provided on a first end which is a distal end of the larger-diameter portion, the flat blade cutting an object to be cut, and a metal member which can be attracted by the magnet provided on the support member, the metal member being provided on a second end which is a distal end of the smaller-diameter portion, a plurality of contact portions provided on axially differing portions of the shaft respectively, the contact portions being capable of contacting the bearings respectively, and a plurality of thinned parts provided between the contact portions and extending in the axial direction of the shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a perspective view of a cutting apparatus according to one example;

FIG. **2** is a plan view of the cutting apparatus;

FIG. **3** is a longitudinally sectional left side view taken along line III-III in FIG. **2**;

FIG. **4** is a perspective view of a cutting head;

FIG. **5** is a front view of cutting member;

FIG. **6** is a sectional view of the cutting member;

FIG. **7** is a perspective view of a cutter;

FIG. **8** is a side elevation of the cutter; and

FIG. **9** is a sectional view of the cutter including first and second plates.

DETAILED DESCRIPTION

One example including a cutter, a cutting member and a cutting apparatus will be described with reference to the accompanying drawings.

Construction of a Cutting Apparatus **100**

The construction of the cutting apparatus **100** will be described with reference to FIG. **1**. The cutting apparatus **100** is configured to cut an object **160** and includes a housing **110**, a platen **250**, a machine frame **11**, a cutting head **130**, a transfer mechanism **140**, a cutter moving mechanism **150**, a display **170**, switches **172** and a scanner **180**.

Defining the directions, a transferring direction of the transfer mechanism **140** is referred to as "front-rear direction (Y-direction)." A moving direction of the cutter moving mechanism. **150** is referred to as "right-left direction (X-direction)." A direction perpendicular to the front-rear direction and the right-left direction is referred to as "up-down direction (Z-direction)."

The housing **110** encloses the transfer mechanism **140**, the platen **250** and the cutting head **130**. The housing **110** is formed into the shape of a box elongated in the right-left direction. The housing **110** has a front formed with an insertion hole **111** and a rear formed with a rear hole **112**. The insertion hole **111** extends in the right-left direction. A holding member **51** is to be inserted into the insertion hole **111**.

The machine frame **11** is mounted on the housing **110**. The machine frame **11** includes two sidewalls **11**B and **11**A located at right and left sides of the platen **250** respectively. The sidewalls **11**A and **11**B have respective surfaces facing each other. The sidewalls **11**A and **11**B have openings **11**C through which a timing belt **31** passes, respectively. Each opening **11**C is formed into a square shape. The timing belt **31** will be described later.

The holding member **51** holding the object **160** is inserted through the insertion hole **111** and then transferred along a transfer path extending from the insertion hole **111** to the rear hole **112**. The transfer path is provided along a flat surface of the platen **250** over the platen. The transfer mechanism **140** is configured to transfer the holding member **51** placed on the platen **250** in the front-rear direction. The holding member **51** will be described in detail later.

The display **170** and the switches **172** are mounted on a right-hand part of the front of the housing **110**. The display **170** is a full-color liquid crystal display, for example. The switches **172** are operated by a user. The operation may include various instructions, selection and input. The switches **172** include a touch panel mounted on the surface of the display **170**. The display **170** is configured to display a plurality of types of patterns, messages to be informed of the user, and the like. The user operates the switches **172** to select a pattern displayed on the display **170**, to set various parameters, to instruct functions and the like.

The Holding Member **51**

The holding member **51** will foe described with reference to FIG. **1**. The holding member **51** is configured to hold the object **160** which is paper, cloth or the like. The object **160** is formed into the shape of sheet. The holding member **51** is formed into the shape of a rectangular flat plate. The holding member **51** holding the object **160** is inserted through the insertion hole **111** of the housing **110** to be placed on the platen **250**. The holding member **51** includes a base **52** and a holding portion **53**. The base **52** is made of synthetic resin. However, the base **52** may be formed of pasteboard or metal plate, instead. The holding portion **53** is disposed on the surface of the base **52**. The holding portion **53** is configured to removably hold the predetermined object **160**. The holding portion **53** is located in a generally rectangular inside region of the upper surface of the base **52**. The holding portion **53** is an adhesive layer, for example. The object **160** is affixed to the adhesive layer thereby to be held by the holding member **51**.

The Transfer Mechanism **140**

The transfer mechanism **140** will be described in detail with reference to FIG. **2**. The transfer mechanism **140** includes a driving roller **12**, a pinch roller **13**, amounting frame **14**, a Y-axis motor **15**, a driving gear **16**, a driven gear **17** and a pair of coil springs **18**. The driving roller **12** and the pinch roller **13** are disposed between the right and left sidewalls **11**B and **11**A so as to extend in the right-left direction.

The sidewalls **11**A and **11**B support both ends of the driving roller **12** so that the driving roller **12** is rotatable. The driven gear **17** is secured to the right end of the driving roller **12**. The mounting frame **14** is mounted on an outer surface of the right sidewall **11**B. The Y-axis motor **15** is mounted on the mounting frame **14**. The Y-axis motor **15** may comprise a stepping motor, for example. The driven gear **17** is brought into mesh engagement with the driving gear **16**. The driving gear **16** has a smaller diameter than the driven gear **17**. The driving gear **16** is fixed to an output shaft of the Y-axis motor **15**. Upon rotation of the Y-axis motor **15**, its rotational driving force is transmitted via the driving gear **16** and the driven gear **17** to the driving roller **12**, whereby the driving roller **12** is rotated by the Y-axis motor **15**.

The pinch roller **13** has right and left ends supported by the sidewalls **11**B and **11**A so as to be rotatable and so as to be slightly displaceable in the up-down direction, namely, in the thicknesswise direction of the object **160**. The pinch roller **13** is normally biased downward at the outer surface sides of the sidewalls **11**A and **11**B by the coil springs **18**. The coil springs **18** are disposed between both ends of the pinch roller **13** and the sidewalls **11**A and **11**B respectively. The pinch roller **13** includes two roller portions **13**A and **13**B disposed at both ends thereof respectively. The roller portions **13**A and **13**B have larger respective diameters than the pinch roller **13**.

The holding member **51** has right and left edges which are held between the driving roller **12** and the roller portions **13**A and **13**B respectively. When the driving roller **12** is rotated by the drive of the Y-axis motor **15**, the holding member **51** is transferred in the front-rear direction by the transfer mechanism **140** while the edges of the holding member **51** are held between the driving roller **12** and roller portions **13**A respectively.

The Cutter Moving Mechanism **150**

The cutter moving mechanism **150** will be described in detail with reference to FIG. **2**. The cutter mechanism **150** is configured to move the cutting head **130** in the right-left direction intersecting the direction in which the holding member **51** is transferred. The cutter moving mechanism **150** includes a guide shaft **21**, a mounting plate **23**, an auxiliary mounting plate **24**, an X-axis motor **25**, a pulley shaft **26**, a driving gear **27**, a left timing pulley **28**, a driven gear **29**, a right timing pulley **30**, an endless timing belt **31** and a mounting portion **32**. The guide shaft **21** is disposed so as to extend in the right-left direction between the right and left sidewalls **11**B and **11**A and so as to be located above the pinch roller **13** in the rear of the pinch roller **13**. The cutting head **130** is moved along the guide shaft **21** in the right-left direction.

The mounting plate **23** is mounted on a rear part of the outer surface of the left sidewall **11**A. The auxiliary mounting plate **24** is mounted on the outer surface of the right sidewall **118**. The X-axis motor **25** is mounted on a rear part of the mounting plate **23**. The pulley shaft **26** is rotatably mounted on a front part of the X-axis motor **25** and extends in the up-down direction. The driving gear **27** is fixed to an output shaft of the X-axis motor **25**. The left timing pulley **28** and the driven gear **29** are rotatably supported, by the pulley shaft **26**. The left timing pulley **23** and the driven gear **29** are formed integrally with each other, thereby being rotated together. The driven gear **29** is brought into mesh engagement with the driving gear **27**.

The right timing pulley **30** is rotatably mounted on the auxiliary mounting plate **24**. The endless timing belt **31** extends between the right and left timing pulleys **30** and **28** horizontally in the right-left direction. The timing belt **31** includes a midway part coupled to the mounting portion **32** as shown in FIG. **3**. The mounting portion **32** is disposed on the rear of the carriage **19** and caused to protrude rearward with respect to the carriage **19** to be coupled to the timing belt **31**. Upon rotation of the X-axis motor **25**, the rotational driving force thereof is transmitted via the driving gear **27**, the driven gear **29** and the left timing pulley **28** to the timing belt **31**. As a result, the carriage **19** is moved in the right-left direction by the X-axis motor **25**.

The Scanner **180**

The scanner **180** will be described in detail with reference to FIG. **3**. The scanner **180** is configured to read an image of the surface of the object **160** transferred by the transfer mechanism **140**. The cutting apparatus **100** is configured to generate cutting data based on the image of the surface of the object **160** read by the scanner **180**. The cutting data is used to cut the object **160**.

The Platen **250**

The platen **250** will now be described in detail with reference to FIG. **3**. The platen **250** is located opposite the scanner **180** with the transfer path being interposed therebetween. The platen **250** has a flat surface on which the holding member **51** holding the object **160** is placeable. The platen **250** receives the underside of the holding member **51** when the cutting apparatus **100** cuts the object **160**. The platen **250** is mounted on the machine frame **11** and has a horizontal upper surface. The driving roller **12** and the pinch roller **13** are disposed substantially on the center of the platen **250** with respect to the front-rear direction. The driving roller **12** is disposed under the pinch roller **13**. The driving roller **12** has an upper end substantially flush with the upper surface of the platen **250**. The holding member **51** is transferred while being placed on the platen **250** with the object **160** being held on the holding member **51**.

The Cutting Head **130**

The cutting head **130** will be described in detail with reference to FIGS. **3** and **4**. The cutting head **130** includes the carriage **19**, a cutter holder **20** and an up-down moving mechanism **36**. The carriage **19** constitutes a rear part of the cutting head **130**, and the up-down moving mechanism **36** constitutes a left part of the cutting head **130**. The cutter holder **20** constitutes a right part of the cutting head **130**. The carriage **10** includes two guide cylinders **22** and a sliding contact **35**. The guide cylinders **22** are disposed at both sides of the carriage **19** in the right-left direction. The guide shaft **21** is inserted through the guide cylinders **22**. The sliding contact **35** is downwardly open and is formed so as to have a generally U-shaped section. The sliding contact **35** is further formed into the shape of a thin plate extending in the right-left direction. The sliding contact **35** has an inner surface which is brought into sliding contact with the pinch roller shaft **13**. The pinch roller shaft **13** is supported so as to be displaceable in a direction of thickness of the object **160**. Accordingly, the sliding contact **35** slidingly contacts with the pinch roller shaft **13** so as to be movable relatively along the direction of displacement of the pinch roller shaft **13**. The sliding contact **35** is formed into such a shape as to pinch the pinch roller shaft **13** in the front-rear direction. The sliding contact **35** is moved along a part of the pinch roller shaft **13** defined between rollers **13**A and **13**B mounted on the roller shaft **13**. The sliding contact **35** is mounted on a lower end of the carriage **19** and maintains the position of the cutting head **130**.

The cutter holder **20** includes a mounting cylinder **47** which is formed into a cylindrical shape and extends in the up-down direction. A cutting member **400** is detachably attached to the mounting cylinder **47** by screws (not shown). The cutting member **400** includes a cutter **300** as shown in FIG. **3**.

The up-down drive mechanism **36** includes a mounting plate **37**, a Z-axis motor **38**, an intermediate gear **39** and a rack member **43**. The mounting plate **37** is provided at the left side of the front of the carriage **19** and formed into a crank shape. The Z-axis motor **38** is mounted on the left, end front of the carriage **19** and may be a stepping motor **38**, for example. The Z-axis motor **38** has an output shaft to which a driving gear (not shown) is fixed. This driving gear is brought into mesh engagement with the intermediate gear **39**. The intermediate gear **39** is rotatably supported on the mounting plate **37**. A smaller gear (not shown) having a smaller diameter than the intermediate gear **39** is coaxially formed on the intermediate gear **39**. The intermediate gear **39** and the smaller gear are rotated together. The rack member **47** is provided on the left side of the mounting cylinder **47**, extending in the up-down direction. The rack member **43** includes a rack portion **43**A formed on a left wall of the rack member **43** and extending in the up-down direction. The rack portion **43**A is brought into mesh engagement with the smaller gear.

Upon drive of the Z-axis motor **38**, the driving gear is rotated, whereby the intermediate gear **35** and the smaller gear are rotated with the result that the rack member **43** is moved in the up-down direction. As a result, the cutter holder **20** is moved upward or downward. More specifically, the cutter holder **20** is moved between a raised position where the blade edge of the cutter **300** is spaced from the object **160** by a predetermined distance and a lowered position where the blade edge of the cutter **300** penetrates through the object **160**.

When the cutter holder **20** is lowered by the up-down drive mechanism **36**, the blade edge of the cutter **300** abuts against the object **160**. While the blade edge is in abutment with the object **160**, the holding member **51** is moved freely in the front-rear direction by the transfer mechanism **140**, and the cutting head **130** is moved freely in the right-left direction by the cutter moving mechanism **150**. As a result, the object **160** is cut by the cutter **300**.

The Cutting Member **400**

An external construction of the cutting member **400** will be described with reference to FIG. **5**. The cutting member **400** includes a supporting member **402** which supports the cutter **300**. The supporting member **402** includes an enclosure case **405**. The enclosure case **405** includes a case body **420**, a cap **430** provided on one end of the case body **420** and a knob **410** provided on the other end of the case body **420**. The enclosure case **405** is formed of a resin material and extends in the up-down direction. The case body **420** has a stepped portion **495** at the lower side. As a result, the case body **420** has a lower portion with a smaller diameter and is formed into a stepped cylindrical shape.

The cap **430** includes a larger-diameter portion **431** and a smaller-diameter portion **432** both corresponding to the stepped portion **405** of the case body **420**. The cap **430** is formed into a stepped bottomed cylindrical receptacle. The larger-diameter portion **431** has an outer circumferential surface formed with a plurality of narrow grooves at regular intervals. The grooves are formed in a lower part of the larger-diameter portion **431** than a central part in the up-down direction so as to extend in the up-down direction. The grooves serves as a slip-proof in the case where the user grip pinches the cap **430** with his/her fingers to rotate the cap **430**.

An inner structure of the cutting member **400** will be described with reference to FIG. **6**. Two storage spaces **491***a* and **491***b* are defined in the supporting member **402**. A mounting member **498** is stored in the storage space **491***a*, and the cutter **300** is stored in the storage space **491***b*. More specifically, the storage spaces **491***a* and **491***b* are defined in case body **420**. The storage space **491***a* is located in an upper half of the cutting member **400**, and the storage space **491***b* is located in a lower half of the cutting member **400**. The storage spaces **491***a* and **491***b* communicate with each other. The storage space **491***b* is defined as a recess into which a shaft **320** of the cutter **300** and a metal member **340** are insertable. The storage space **491***b* has an inner diameter substantially equal to an outer diameter of the shaft **320** of the cutter **300**.

The storage space has an upper end and a lower end provided with bearings **460** and **470** respectively. The bearing **470** may be a rolling bearing such as a ball bearing. The bearing **460** may be a sliding bearing comprising a metal alloy, for example. The bearing **460** is disposed in an inner side of the storage space **491***b* spaced away from a blade **330** of the cutter **300**. The bearing **470** is disposed in the front side of the storage space **491***b* near the blade **330**, supporting the shaft **320**. The cutter **300** has an axial length (namely, a length of the shaft **320** in the direction of the axis **310**) that is longer than a distance between the bearings **460** and **470**.

The mounting member **498** is secured to the bottom of the storage space **491***a* in the case body **420**. The mounting member **498** has two mounting holes **498***a* and **498***b* both formed therein. Each mounting hole has a square section in order that knob **410** may be mounted therein. A magnet **440** is mounted on the central underside of the mounting member **498** and located on the bottom of the storage space **491***b*. The metal member **340** of the cutter **300** is attracted upward by the magnetic force of the magnet **440**. The magnet **440** attracts the cutter **300** thereby to hold the cutter **300**. The magnet **440** is disposed on an extension extending from the metal member **340** in the direction of the central axis L**1** (see FIG. **5**). Accordingly, when inserted into the cutting member **400** form below, the cutter **300** is attracted upward by the magnetic force of the magnet **440**. The cutter **300** is then held at a position where the stepped portion between the shaft **320** and the larger-diameter portion **350** is engaged with and locked to an end surface of the bearing **470**. In this case, the cutter **300** is held so as to be prevented, from movement along the direction of the central axis L**1**. A support **492** includes the magnet **440** and the bearings **460** and **470**.

The case body **420** has a male thread **443** formed on the outer circumference thereof. The male thread **448** is brought into mesh engagement with a female thread **449** of the cap **430**. The female thread **449** is formed in the inner circumference of the larger-diameter portion **431** of the cap **430**. The cap **430** is combined with the case body **420** as the result of threading engagement of the threads **448** and **449**. In this case, the cap **430** is combined with the case body **420** so that the position thereof in the direction of the central axis L**1** is adjustable.

The smaller-diameter portion **432** of the cap **430** has an underside **440***a* which is formed into a circular horizontal flat surface. The underside **440***a* of the smaller-diameter **432** is brought into face-to-face contact with the object **160**. The underside **440***a* is formed with a hole **440***b* through which the blade **330** of the cutter **300** is passable. The cap **430** is assembled to the case body **420** so as to be substantially prevented from backlash at least in a radial direction.

A compression coil spring **497** mounted on a lower part of the case body **420** is enclosed in the larger-diameter portion **431**. Thus, the cap **430** is normally biased downward by the compression, coil spring **497**. Accordingly, the threads **448** and **449** engaged with each other are prevented from backlash with the result that an amount of projection of the blade **330** can be adjusted precisely. A small protrusion **496** is formed on the lower part of the case body **420** so as to be located at the stepped portion **495** side. The protrusion **496** is engaged with and locked to an upper end of the spring **497**. Accordingly, the spring **497** can be prevented from detachment from the case body **420** even when the cap **430** is detached from the case body **420** during replacement of the cutter **300** or the like.

The cutter **300** is held in the case body **420** by the magnetic attractive force of the magnet **440** and the stepped portion between the shaft **320** and the larger-diameter portion **350** thereof. In this case, the cutter **300** is held so as to be pulled upward and so as to be prevented from upward movement. Accordingly, when replacing the cutter **300**, the user can easily detach the cutter **300** from the case body **420** only by pulling the cutter **300** downward against the magnetic attractive force of the magnet **440**.

The Cutter **300**

The construction of the cutter **300** will foe described with reference to FIGS. **7** and **8**. The cutter **300** includes the shaft **320**, the blade **330** and the metal member **340**. The shaft **320** is formed into the shape of a round bar and extends in the direction of the axis **310**. The shaft **320** includes an upper part and a lower part both of which serve as supporting portions as will be described later. The upper and lower portions of the shaft **320** have sections which are circular, more specifically, a section which is taken in the direction perpendicular to the axis **310** and is circular. The shaft **320** is formed of a resin such as ABS resin. However, the shaft **320** may be formed of another resin. The shaft **320** is supported by the supporting member **402**. More specifically, the shaft **320** has two support portions which are supported by the bearings **460** and **470** so as to be rotatable.

The shaft **320** includes the larger-diameter portion **350** and a smaller-diameter portion **370**. The larger-diameter portion **350** is formed into a substantially columnar shape and has a larger outer diameter than the smaller-diameter portion **370**. More specifically, the outer diameter MD of the larger-diameter **350** is larger than a width BD of the blade **330** as shown in FIG. **3**. When the metal member **340** is attracted by the magnet **440**, the larger-diameter portion **350** abuts on the end surfaces of the bearings **460** and **470** thereby to be locked so as to be immovable in the direction of the axis **310**. The larger-diameter portion **350** has a concavo-convex portion **360** formed in the central part thereof in the up-down direction. The concavo-convex portion **360** includes an axially central part having a smaller outer diameter than both axial ends of the concavo-convex portion **360**. When pinching the concavo-convex portion **360** with his/her fingers, the user can handle the cutter **300** in safety without touching the blade **330**.

The smaller-diameter portion **370** is located at the metal member **340** side in the direction of the axis **310**. The smaller-diameter portion **370** is formed into a generally columnar shape and has an outer diameter which is substantially equal to inner diameters of the bearings **460** and **470**. The smaller-diameter portion **370** is rotatably supported by the bearings **460** and **470** with the axis **310** serving as the center thereof.

The blade **330** is provided on a first one or both axial ends of the shaft **320**, which first end is a distal end of the larger-diameter portion **350**. The blade **330** is a flat blade comprising a flat metal plate. The blade **330** is embedded in the first end of the shaft **320**. The blade **330** has a distal end which is inclined relative to the object **160** and formed into a generally triangular shape and is provided for cutting the object **160**. The axis **310** passes a thicknesswise and widthwise centers of the blade **330**. A blade part is provided on the first end which is further away from the shaft **320** than the other end of the blade **330**.

The metal member **340** is provided on a second one of the axial ends of the shaft **320**, which second end is a distal end of the smaller-diameter portion **370**. The second end is located opposite the first end. The metal member **340** is made of a magnetic material and is a metal flat plate which can be attracted by the magnet **440**. The metal member **340** is embedded in the upper end of the shaft **320**. The metal member **340** may be molded from a resin containing magnetic powder.

Method of Manufacturing the Cutter **300**

A method of manufacturing the cutter **300** will be exemplified with reference to FIG. **9**. The manufacturing method should not be limited to this example. The blade **330** and the metal member **340** are made of the same metal plate in the example.

Firstly, a metal plate is pressed to be formed into a laterally-facing T-shaped first plate **380** and an inverted L-shaped second plate **390**. The metal plate has a plate thickness of 0.5 mm, for example.

A lower end of the first plate **330** is sharpened at a next process. The first and second plates **380** and **390** are set in a metal die of an injection machine (not shown) at a further next process. The shaft **320** is insert-molded between the first and second plates **380** and **390**. In this case, if the first and second plates **380** and **390** are a single combined plate member, there is a possibility that resin injection pressure would deform the plate member during the insert molding. When the plate member is deformed, the molded shaft **320** (the axis **310**) would bend. In the example, however, adverse effects of the resin injection pressure can be avoided since two separated first and second plates **380** and **390** are used. Accordingly, the shaft **320** and accordingly, the entire cutter **300** can be manufactured with desirable precision. Furthermore, the cutter **300** can be manufactured at lower costs as compared with the case where a whole cutter is cut out of a metal bar material.

Subsequently, the first plate **380** has an excess part extending from the larger-diameter portion **350** in the direction perpendicular to the axis **310**. The excess part of the first plate **380** is cut. Thus, the blade **330** is made of the first plate **380**.

Furthermore, the second plate **390** has an excess part extending from an end of the shaft **320** located opposite the blade **330**. The excess part of the second plate **390** is cut. Thus, the metal member **340** is made of the second plate **390**.

Advantageous Effect

The shaft **320** of the cutter **300** comprises the resin in the above-described example. Accordingly, the cutter **300** can be manufactured at lower costs as compared with the case where the cutter is cut out of a metal bar material. Furthermore, since the metal member is located at the second end of the shaft **320**, the cutter **300** is attracted by the magnet **440** provided on the support member **402** supporting the cutter **300**. Consequently, the cutter **300** can be easily attached and detached. The cutter **300** is held with the bearing in abutment on the smaller-diameter portion **370** of the shaft **320**, whereby the cutter **300** can be supported so as to be rotatable about the axis. Furthermore, when the metal member **340** is attracted by the magnet **440**, the stepped portion (the proximal end surface of the large-diameter portion **350**) formed between the larger-diameter portion **350** and the smaller-diameter portion **370** abuts on the end surface of the bearing. As a result, the cutter **300** can be rendered immovable in the axial direction, whereby the cutter **300** is locked in the state where the axial position of the cutter **300** relative to support member **402** is immovable. Still furthermore, since the metal member **340** does not directly abut on the magnet **440**, the cutter **300** can foe rotated about the axis more easily as compared with the case where the metal member directly abuts on the magnet.

The foregoing description and drawings are merely illustrative of the present disclosure and are not to be construed in a limiting sense. Various changes and modifications will become apparent to those of ordinary skill in the art. All such changes and modifications are seen to fall within the scope of the appended claims.

What is claimed is:

1. A cutter which is detachably attachable to a support member, the cutter comprising:

a shaft made of a resin and having a smaller-diameter portion and a larger-diameter portion with a larger diameter than the smaller-diameter portion, the smaller-diameter portion and the larger-diameter portion being formed integrally with the shaft, the smaller-diameter portion being rotatably supported by a plurality of bearings provided on the support member, the larger-diameter portion having a proximal end surface abutting on an end surface of one of the bearings, with a result that the cutter is locked in a state where an axial position of the cutter relative to the support member is immovable;

a flat blade provided on a first end which is a distal end of the larger-diameter portion, the flat blade cutting an object to be cut;

a metal member which can be attracted by a magnet provided on the support member, the metal member being provided on a second end which is a distal end of the smaller-diameter portion;

a plurality of contact portions provided on axially differing portions of the shaft respectively, the contact portions being capable of contacting the bearings respectively; and

a plurality of thinned parts provided between the contact portions and extending in the axial direction of the shaft.

2. The cutter according to claim **1**, wherein the larger-diameter portion has an outer diameter which is larger than a width of a cutting part of the flat blade.

3. The cutter according to claim **1**, wherein the larger-diameter portion has an axially central part formed with a recess which is smaller than an outer diameter of the larger-diameter portion, and the recess is formed with a concavo-convex portion.

4. The cutter according to claim **2**, wherein the larger-diameter portion has an axially central part formed with a recess which is smaller than the outer diameter of the larger-diameter portion, and the recess is formed with a concavo-convex portion.

5. The cutter according to claim **1**, wherein the flat blade and the metal member provided on the second end of the smaller-diameter portion are made from an identical material.

6. A cutting member comprising:

a support member to which a cutter is detachably attached, thereby supporting the cutter, the support member having a plurality of bearings rotatably supporting the cutter and a magnet configured to position the cutter, the cutter including:

a shaft made of a resin and having a smaller-diameter portion and a larger-diameter portion with a larger diameter than the smaller-diameter portion, the smaller-diameter portion and the larger-diameter portion being formed integrally with the shaft, the smaller-diameter portion being rotatably supported by the bearings provided on the support member, the larger-diameter portion having a proximal end surface abutting on an end surface of one of the bearings, with a result that the cutter is locked in a state where an axial position of the cutter relative to the support member is immovable;

a flat blade provided on a first end which is a distal end of the larger-diameter portion, the flat blade cutting an object to be cut;

a metal member which can be attracted by the magnet provided on the support member, the metal member being provided on a second end which is a distal end of the smaller-diameter portion;

a plurality of contact portions provided on axially differing portions of the shaft respectively, the contact portions being capable of contacting the bearings respectively; and

a plurality of thinned parts provided between the contact portions and extending in the axial direction of the shaft.

7. The cutting member according to claim **6**, wherein the larger-diameter portion has an outer diameter which is larger than a width of a cutting part of the flat blade.

8. The cutting member according to claim **6**, wherein the larger-diameter portion has an axially central part formed with a recess which is smaller than an outer diameter of the larger-diameter portion, and the recess is formed with a concavo-convex portion.

9. The cutting member according to claim **7**, wherein the larger-diameter portion has an axially central part formed with a recess which is smaller than the outer diameter of the larger-diameter portion, and the recess is formed with a concavo-convex portion.

10. The cutting member according to claim **6**, wherein the flat blade and the metal member provided on the second end of the smaller-diameter portion are made from an identical material.

11. A cutting apparatus comprising:

an object transfer mechanism configured to transfer a holding member holding an object to be cut;

a cutter moving mechanism configured to move a cutting head provided with a holder in a direction intersecting a direction in which the holding member is transferred;

a cutting member attached to the holder, the cutting member including:

a support member to which a cutter is detachably attached, thereby supporting the cutter, the support member having a plurality of bearings rotatably supporting the cutter and a magnet configured to position the cutter, the cutter including:

a shaft made of a resin and having a smaller-diameter portion and a larger-diameter portion with a larger diameter than the smaller-diameter portion, the smaller-diameter portion and the larger-diameter portion being formed integrally with the shaft, the smaller-diameter portion being rotatably supported by the bearings provided on the support member, the larger-diameter portion having a proximal end surface abutting on an end surface of one of the bearings, with a result that the cutter is locked in a state where an axial position of the cutter relative to the support member is immovable;

a flat blade provided on a first end which is a distal end of the larger-diameter portion, the flat blade cutting an object to be cut;

a metal member which can be attracted by the magnet provided on the support member, the metal member being provided on a second end which is a distal end of the smaller-diameter portion;

a plurality of contact portions provided on axially differing portions of the shaft respectively, the contact portions being capable of contacting the bearings respectively; and

a plurality of thinned parts provided between the contact portions and extending in the axial direction of the shaft.

12. The cutting apparatus according to claim **11**, wherein the larger-diameter portion has an outer diameter which is larger than a width of a cutting part of the flat blade.

13. The cutting apparatus according to claim **11**, wherein the larger-diameter portion has an axially central part formed with a recess which is smaller than an outer diameter of the larger-diameter portion, and the recess is formed with a concavo-convex portion.

14. The cutting apparatus according to claim **12**, wherein the larger-diameter portion has an axially central part formed with a recess which is smaller than the outer diameter of the larger-diameter portion, and the recess is formed with a concavo-convex portion.

15. The cutting apparatus according to claim **11**, wherein the flat blade and the metal member provided on the second end of the smaller-diameter portion are made from an identical material.

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